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ATOMIC FORCE MICROSCOPY STUDIES OF SOLUTION CRYSTAL

GROWTH MORPHOLOGY AND DYNAMICS, J.J. De Yoreo, T.A. Land, and J.D. Lee, Lawrence Livermore National Laboratory, Livermore, CA 94550, A.J. Malkin, Yu. G. Kuznetsov and A. McPherson, University of California at Riverside, Riverside, CA, 92521

The atomic force microscope is well suited for investigating the growth of single crystal surfaces in solutions at the 10nm to 100 μ m length scale both in real time and ex situ. In this talk I will present the results from studies on two systems: the simple ionic salt, KH₂PO₄ (KDP) with a molecular size of 3-5Å and the storage protein canavalin with a molecular size of 40-80Å. At supersaturations of $0.05 \leq \Delta\mu/kT \leq 0.3$, KDP growth typically occurs by step-flow on anisotropic hillocks formed by dislocation sources which generate hollow cores due to strain effects. The terrace width on the growth hillocks is nearly independent of both the Burgers vector of the dislocation source, b , and $\Delta\mu/kT$, in contradiction to the simple BCF model. A model which takes into account the presence of the cores predicts terrace widths in agreement with the measured values. The results provide an explanation for the reproducibility of macroscopic growth rates and lead to a value for the activation energy for elementary step motion of 0.33eV. At low supersaturation, canavalin growth also proceeds by step flow on complex dislocation hillocks but, in contrast to KDP, agrees well with BCF predictions of morphology. At high supersaturation, dislocation controlled growth gives way to 2D nucleation of islands. The magnitude of the step current and the time dependence of step-pair decay is consistent with a surface diffusion model of growth coupled with a Ehrlich-Schwoebel barrier at the step edge. From the dependence of 2D nucleation on terrace width we estimate the canavalin diffusion length to be 1-10 μ m. Analysis of the step dynamics within the Gilmer-Ghez-Cabrerra formalism leads to estimates for the surface diffusion length, activation energy for adsorption and for incorporation of 1 μ m, 0.1eV and 0.2eV respectively. From the dependence of critical step length and terrace width on $\Delta\mu/kT$ we calculate the step edge free energy to be 0.8eV.

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Presenting and Contact Author Information:

James J. De Yoreo
Lawrence Livermore National Laboratory
7000 East Avenue, L-250
Livermore, CA 94550
Phone: (510) 423-4240
FAX: (510) 422-3361
E-Mail: deyoreo1@llnl.gov